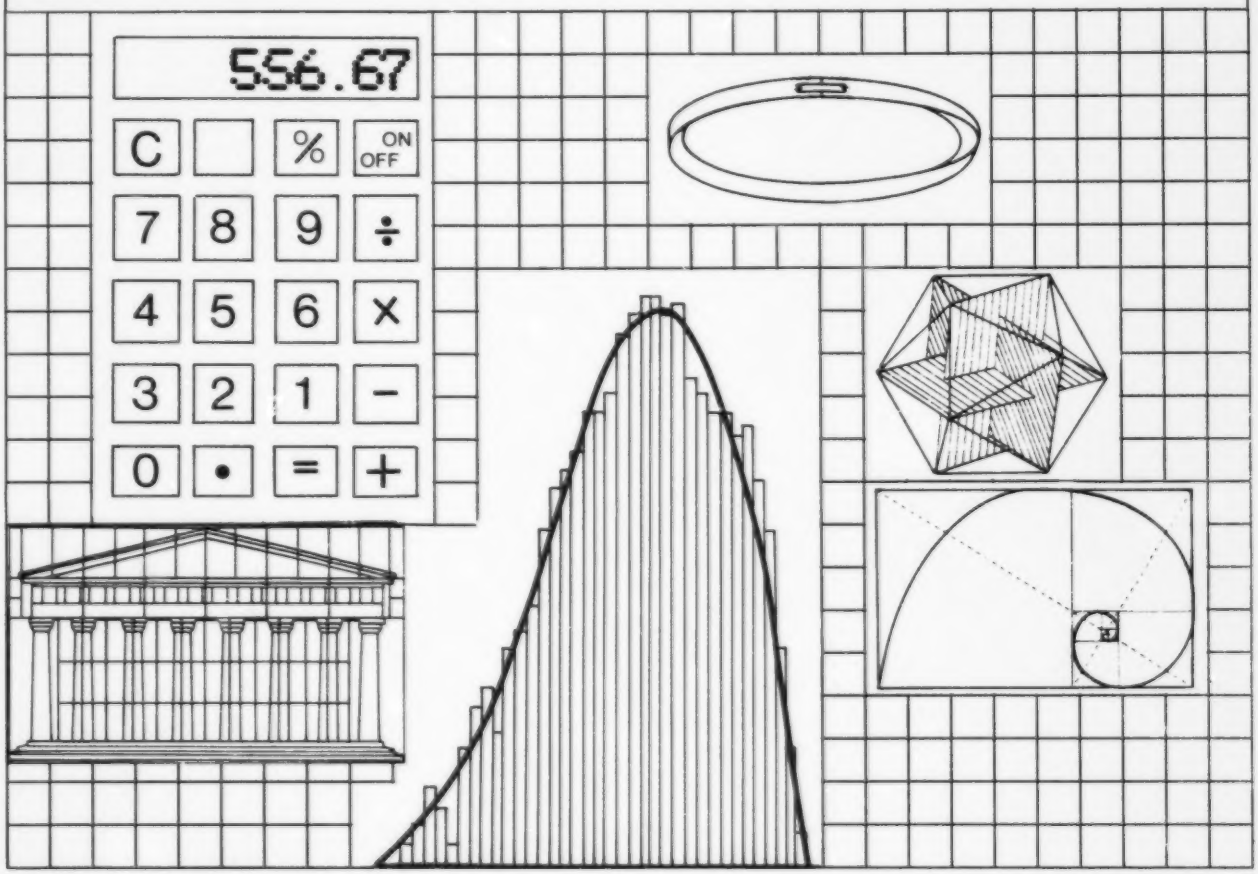
MATHEMATICS ASSESSMENT

ENGLISH LANGUAGE AND FRENCH IMMERSION PROGRAMS

1987

SUMMARY REPORT



Manitoba
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MATHEMATICS ASSESSMENT 1987

SUMMARY REPORT

ENGLISH LANGUAGE AND FRENCH IMMERSION

A REPORT OF THE

CURRICULUM DEVELOPMENT AND IMPLEMENTATION BRANCH

MANITOBA EDUCATION

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PREFACE

This Summary Report is the third of three reports of the findings of the 1987 Mathematics Assessment. It contains a brief description of the study along with recommendations based upon the judgments of the Technical Advisory Committee. Members of the Committee reviewed the data and interpreted them in light of their considerable knowledge and experience. Teachers and school administrators are encouraged to review the recommendations for applicability to their own programs.

There are two other reports on this assessment. They are the Preliminary Report which presents the individual and subtest data, and the Final Report which analyzes the data and presents conclusions and recommendations.

The Preliminary Report was distributed to all schools in the province as well as to school division offices, to teacher and trustee organizations, to libraries, and to the universities. This Summary Report will receive the same distribution as the Preliminary Report, while the more extensive Final Report will be distributed only to school division offices, teacher and trustee organizations, libraries, and universities. Copies of the Final Report, however, can be obtained from Manitoba Education on request.

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- The contract team who gave professional assistance in every phase of the project.
- The Joint Committee on Evaluation which provided guidance throughout the program.
- The Mathematics Technical Advisory Committee which advised on test production and analysis of results.
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MATHEMATICS SUMMARY REPORT

The 1987 Mathematics Assessment is the second mathematics assessment conducted in Manitoba. The first assessment took place in the spring of 1981 and provided an indication of performance in mathematics of public school students in the province. The 1987 student assessment instruments were administered in May and June at grade levels 3, 6, 9, and 12. The purposes of the 1987 and the 1981 assessments were similar and are:

1) to provide benchmark indicators relative to the level of mathematics achievement in Manitoba,

2) to obtain data on student mathematics achievement which will assist in curriculum and program improvement at various levels,

3) to assist school divisions with student evaluations in mathematics,

4) to help teachers improve their skills in evaluating students in mathematics.

There were three facets to the 1987 assessment program:

Student Performance. This was an assessment of the prescribed mathematics curriculum learned by Manitoba students.

Comparison Testing. This was a comparison of 1981 and 1986 student performance in mathematics, based on the 1981 test instrument.

Teacher Survey. A survey of mathematics teachers in grades 3, 6, 9, and 12 regarding demographic data, classroom practices, and curricular views.

Nature of the Assessment

The Manitoba mathematics program consists of a large number of skills and objectives categorized in major topic areas. For grades 3 and 6, the following topics were delineated:

Number systems and operations - conducting calculations and using operations with whole numbers and fractions.

Measurement - using the appropriate measures in the metric system and determining such things as length, area, and volume.

Geometry - recognizing shapes and using notions of position and angle.

Graphing - interpreting graphs.

Problem solving - including both routine and nonroutine problems.

At the grade 9 and 12 levels the topic areas are course specific and based upon the respective curriculum guides. The topics are listed in Tables 5, 7, and 9 with the presentation of results.

Procedures

The student tests were developed from objectives based upon the provincial curriculum guides and identified as important for assessment by Manitoba teachers. The actual test development was carried out by mathematics education specialists on contract with Manitoba Education. Two pilot tests at each level (grades 3, 6, 9, Mathematics 300 and Mathematics 301) were developed and then were reviewed by the Technical Advisory Committee (TAC), a group of teachers established by the Assessment Section to advise on the entire test development and interpretation process. Final versions were written in light of the pilot testing. All tests were available in both English and French versions. Approximately 10% of all students enrolled in English language and French Immersion programs at grades 3, 6, and 9 and approximately 20% of students in English programs in the grade 12 courses constituted the provincial sample. The results of the testing are discussed in this Summary.

The second component, a comparison of student performance in 1986 with 1981, involved a sample of students at grade levels 3, 6, 9, and 12. Students wrote the same tests in 1986 that students wrote five years earlier. At the grade 12 level this included a general test independent of any course and was written by a sample of all grade 12 students. In addition to this general test, mathematics 300 students wrote the 1981 mathematics 300 test, although some questions were deleted due to curriculum changes since 1981. Mathematics 301 was not tested because of changes in the curriculum.

A teacher survey, a third component in this assessment, was carried out by means of questionnaires sent to samples of teachers of mathematics in grades 3, 6, and 9, and to all second term teachers of Mathematics 300 and Mathematics 301.

Interpretation of Results

All assessment results were gathered and analyzed as percentage scores on topical subtests within each level for the province as a whole; no individual, school, or division results were tabulated. Using the subtest and item data presented in the Preliminary Report, the TAC, augmented by additional teachers at the appropriate grade levels, made interpretations of the student results. These interpretations, together with the teacher survey results, led to a set of recommendations. The comparison results are presented without further interpretation and only an indication of score improvement or decline is provided.

Major Findings of the Student Assessment

The findings are presented here in condensed form by grade level. For greater detail the reader is referred to the Final Report and to the Preliminary Report.

Grade 3

Overall performance at the grade 3 level was considered satisfactory by the Technical Advisory Committee. These results are shown in Table 1. The two subtests on Problem Solving and Estimation were the weakest areas. Place value and basic operations with whole numbers were generally well done. Performances in Measurement, Geometry, and Graphing were all rated satisfactory. Nonroutine problem solving was a new area for assessment and results here were considered satisfactory at this time.

Student performance in computation with whole numbers was generally well done, but weaknesses were apparent in the areas of rounding off and estimation. The item below illustrates a common difficulty in estimating the result of a computation. In this item only 12% of students responded with the expected answer. It appears that most students rounded the sum rather than first rounding the two addends. Students also had some difficulties in relating fractions to their pictorial representation, but they did well on the pattern recognition items.

(22) Estimate the sum: 16 + 27 =

11%	A)	☐	30
3	B)	☐	60
12	*C)	☐	50
72	D)	☐	40
2	N. R.		

Table 1

1987 Provincial Results - Grade 3
(n = 1282)

Subtest	Item Numbers	Number of Items	Percent Correct
I. NUMBER SYSTEMS AND OPERATIONS			
1. Concepts of Whole Numbers	1-7	7	78
2. Place Value	8-11	4	86
3. Addition & Subtraction	12-36	25	69
4. Multiplication & Division	51-72	22	72
5. Fractions	73-76	4	62
6. Patterns	77-79	3	89
Total		**65**	**73**
II. MEASUREMENT			
1. Linear Measurement	80-88	9	68
2. Area and Volume	89-92	4	54
3. Money, Time and Temperature	93-98	6	65
Total		**19**	**64**
III. GEOMETRY	37-44	8	78
IV. GRAPHING	45-46 99-100	4	78
V. PROBLEM SOLVING	47-50	4	30
VI. WORD PROBLEMS*	33-36 47-50 71-72 88	11	51
VII. ESTIMATION*	22-23 31-32	4	23

*Subtests VI and VII contain items that overlap with other subtests.

In the area of measurement, there was some confusion about the relationship between a metre and a centimetre. Area and volume measure also caused some difficulties, as illustrated by performance on the following item:

90 Find the area of this shape. Each box is one square centimetre (cm^2). _____ cm^2

47%	*A)	5 cm^2
13	B)	6 cm^2
3	C)	12 cm^2
10	D)	4 cm^2
15	E)	incorrect
12	N.R.	

Geometry was generally well done, although in an item on perimeter, many students selected the length of one side of the figure only instead of adding up the lengths of the sides.

In routine problem solving, students had more success with addition and multiplication questions than with subtraction and division items. Nonroutine problems require a higher level of thinking skills and students were less successful, although the Committee felt that the results were satisfactory. It may be that many students at this level are still using concrete materials to solve problems of this type--and the test was paper and pencil only.

The comparison of 1981 and 1986 data is presented in Table 2. The data suggest few great differences. Results in whole number division improved, although performance in multiplication declined. Performance in measurement, rated unsatisfactory in 1981, showed encouraging gains. Work with fractions continues to be an area of some difficulty.

The organizational aspects of teaching at grades 3 and 6 have changed little since the 1981 survey. Most teachers teach in single grade, self-contained classrooms. Individual, small and large-group instruction are all used. Concrete materials appear to be widely employed, but their use decreases at the higher grade level. Calculators are used in limited ways at both grade levels, but explicit instruction in their use is infrequent. The Manitoba Curriculum Guide and supplementary materials from Manitoba Education are widely used. Teachers indicated a number of areas in which professional development activity is desired.

Table 2

Comparison Results for 1981 and 1986 - Grade 3
(n = 945)

Subtest		No. of Items	Average[a] % Correct 1981	1986	Change[b] in %
I. NUMBER SYSTEMS, OPERATIONS AND PROPERTIES					
I.A	Concepts of Whole Numbers	3	82	84	+2
I.B	Place Value	6	74	72	-2
I.C1	Addition of Whole Numbers	8	78	78	
I.C2	Subtraction of Whole Number	7	63	62	
I.D1	Multiplication of Whole Numbers	12	79	74	-5
I.D2	Division of Whole Numbers	7	62	66	+4
I.E	Fractions and Decimals	4	52	51	-1
I.G	Patterns	6	62	64	+2
I.H	Applications	8	59	55	-4
II. MEASUREMENT					
II.A	Linear Measurement	12	70	72	+2
II.BC	Area, Volume, and Capacity	4	50	53	+3
II.EFG	Money, Time, and Temperature	7	59	60	+1
II.H	Applications	4	26	27	
III. GEOMETRY		9	75	76	+1
IV. GRAPHING		3	79	79	

[a] Average percent correct figures are rounded to the nearest whole percent.
[b] The change in percent correct for a subtest is given only when the difference in mean scores (average number correct) from 1981 to 1986 is statistically significant ($p<.05$).

Grade 6

The Technical Advisory Committee considered overall performance at the grade 6 level to be satisfactory. The subtest data are shown in Table 3. The two weakest areas were operations with decimals and operations with fractions.

In general, computation with whole numbers was adequately done, including its application to word problems. Results on nonroutine problem solving suggest that more effort is required here. Computational estimation is increasingly important in mathematics and it is a concept that appears to be poorly understood.

Whole number computation was considered generally well done by the TAC, although apparently many students do not understand that division by 0 is undefined. Operations with fractions and operations and rounding off with decimals caused difficulties. Conceptual understanding should enable students to handle an item such as the following even if they have not mastered the computational algorithm:

(69) $8 - \frac{1}{3} =$

44%	*A)	$7\frac{2}{3}$
13	B)	$8\frac{2}{3}$
19	C)	$7\frac{1}{3}$
22	D)	$\frac{7}{3}$
1	E)	
1	N.R.	

Students did satisfactorily on items dealing with what metric units are appropriate in a given situation. Most also know that 1 kilometre = 1000 metres, but not that 0.5 kg = 500 g. There is also still confusion among a large proportion of students about area, perimeter and, in the case of a square, the relationship between them.

Geometry performance was considered very satisfactory by the TAC. While most students were unable to select the isosceles triangle out of a set of triangles, they could name the diameter and radius of a circle, and identify an obtuse angle. Students also did well in reading bar and circle graphs.

Students did well on routine word problems requiring applications of the basic arithmetic operations with whole numbers, fractions, and decimals. Nonroutine problem solving items are by definition more difficult and one should have reasonable expectations of student performance. However, responses well below the chance level indicate difficulties and the need for continued work in this area.

Table 3

1987 Provincial Results - Grade 6
(n = 1391)

Subtest	Item Numbers	Number of Items	Percent Correct
I. NUMBER SYSTEMS AND OPERATIONS			
1. Place Value, Regrouping, and Rounding Off	1-8	8	67
2. Equalities and Inequalities	9-12	4	72
3. Factors, Primes and Composite Numbers	13-16	4	56
4. Properties	17-20	4	72
5. Addition and Subtraction	21-27	7	69
6. Multiplication of Whole Numbers	28-32	5	71
7. Division of Whole Numbers	51-56	6	60
8. Fractions and Percent	57-63	7	65
9. Operations with Fractions	64-71	8	51
10. Operations with Decimals	72-78	7	50
Total		**60**	**63**
II. MEASUREMENT	33-41	9	54
III. GEOMETRY	42-49	8	60
IV. GRAPHING	79-84	6	76
V. PROBLEM SOLVING	85-87 89-90	5	27
VI. WORD PROBLEMS	24,56,67 70,75 85-87 89,90	10	43

Comparison of 1981 and 1986 data (Table 4) reveals overall performance to be about the same, but there are a few noteworthy discrepancies. Skills in place value and rounding off have improved, while performance in operations with fractions and two step word problems have declined significantly. The former is crucial to further progress in mathematics and comes on top of an only marginal performance in 1981, while problem solving has been strongly emphasized in the professional literature as well as in local workshops during this period.

Table 4

Comparison Results for 1981 and 1986 - Grade 6
(n = 823)

	Subtest	No. of Items	Average[a] % Correct 1981	1986	Change[b] in %
I.	NUMBER SYSTEMS, OPERATIONS AND PROPERTIES				
I.ACD	Place Value, Regrouping and Rounding Off	8	64	69	+5
I.E	Equalities and Inequalities	4	86	88	+2
I.F	Patterns	1	42	49	
I.GH	Factors, and Prime and Composite Numbers	5	45	43	-2
I.J	Properties	5	87	82	-5
I.KL	Add. and Subt. of Whole Numbers	11	83	82	-1
I.M	Mult. of Whole Numbers	9	77	74	-3
I.N	Division of Whole Numbers	9	65	64	
I.OV	Fractions and Percent	8	61	60	
I.PQR	Operations with Fractions	10	57	50	-7
I.STU	Operations with Decimals	9	57	57	
II.	MEASUREMENT	9	46	48	+2
III.	GEOMETRY	6	50	50	
IV.	GRAPHING	4	61	63	
I.W1	Word Problems - One Step	6	72	71	
I.W2	Word Problems - Two Step	6	62	57	-5

[a]Average percent correct figures are rounded to the nearest whole percent.
[b]The change in percent correct for a subtest is given only when the difference in mean scores (average number correct) from 1981 to 1986 is statistically significant ($p<.05$).

The teacher survey questionnaires for grades 3 and 6 were similar and the findings likewise had much in common. The results for the two grades are discussed together in the above section on Grade 3.

Grade 9

Overall performance by grade 9 students as well as performance in each of the individual subtests (Table 5) was found by the Technical Advisory Committee to be satisfactory. A number of specific concerns are noted in the detailed reports, including the importance of estimation and the role of the calculator in grade 9 mathematics. Performance in nonroutine problem solving is at a low but not unexpected level at this time. Work in this area is noted for continued emphasis. Almost all grade 9 classes tested elected to write the Algebra option which suggests that it is being widely taught (it is designated core in the French program). Geometry and Consumer Related Topics were each chosen by about 25% of the classes. The statistics option is virtually ignored.

Students did reasonably well with negative fractions and decimals. Likewise they were able to find the square root of a perfect square, but apparently many lack the concept and were unable to approximate the square root of a nonperfect square. Teachers should carefully point out that -24 is read as the opposite of 24.

In their work with open expressions, students did well in evaluating an algebraic expression given values for the variables. On the other hand, the negative sign before a parenthesis still causes difficulty for many. Simpler algebraic equations were very well done, but performance declined with the complexity of the equation. Routine word problems were acceptably done, although they still need attention and should not be neglected with the increased emphasis on nonroutine problems.

The TAC has not provided interpretation of the results on option topics because the results do not represent the province due to teacher selection of the subtests to be written. The results cannot be interpreted beyond their own strata and hence are not reproduced here. Some data are provided in the Preliminary Report and the Final Report.

Performance in 1986 improved from marginal or unsatisfactory in 1981 in a number of areas: Square Root; Angles and Parallel Lines; Algebraic Terminology; Equations; and Graphing. Only the subtest on Word Problems showed a significant decline in performance. Given the current emphasis on problem solving, the TAC found this comparison result disappointing.

Table 5

1987 Provincial Results - Grade 9 Core Topics
(n = 2138)

Subtest	Item Numbers	Number of Items	Percent Correct
1. Real Number System	1-3,5,6,8-11 15,16,54,61	13	50%
2. Construction Geometry	24,25,51 71,72	5	51
3. Open Expressions	13,14,17-19 56-60	10	62
4. Equations	20-23,62-65	8	61
5. Word Problems (routine)	4,7,12,52 53,55,66-70	11	53
6. Word Problems (non-routine)	73-77	5	45

Table 6

Comparison Results for 1981 and 1986 - Grade 9
(n = 1091)

Subtest		No. of Items	Average[a] % Correct 1981	1986	Change[b] in %
I. NUMBER SYSTEMS, OPERATIONS AND PROPERTIES					
I.A1	Basic Operations	16	57	56	
I.A2	Order and Word Problems	4	63	65	+2
I.A3	Square Roots	5	47	51	+4
II. MEASUREMENT		3	53	58	+5
III. GEOMETRY					
III.A	Basic Constructions				
III.B	Angles and Parallel Lines	4	44	47	+3
IV. ALGEBRA					
IV.A1	Terminology	3	57	61	+4
IV.A2	Exponents	5	40	41	
IV.A3	Simplifications	11	57	59	+2
IV.A4	Substitutions	5	62	65	+3
IV.B	Equations	14	53	56	+3
IV.C	Word Problems	4	52	39	-13
V. GRAPHING AND STATISTICS					
V.A	Arithmetic Mean	2	71	68	
V.B	Graphing	3	55	59	+4

[a]Average percent correct figures are rounded to the nearest whole percent.
[b]The change in percent correct for a subtest is given only when the difference in mean scores (average number correct) from 1981 to 1986 is statistically significant ($p<.05$).

The teacher survey results indicated that a single grade in the classroom is the norm for most grade 9 mathematics classes, and about half of these are heterogeneously grouped. Only about one-half (down from 60% in 1981) of grade 9 teachers teach at least half their load in mathematics. One-half of the teachers have two or fewer university courses in mathematics; 25% have none. About 70% of the teachers have attended two or more math inservice programs over the last three years. Total group explanations and demonstrations are used daily in most classes and the majority follow a single textbook. Calculators are used frequently, but computers infrequently. The Curriculum Guide is widely used as are materials from inservice programs. Teachers also indicated a number of areas in which professional development activity is desired: remediation, enrichment, problem solving, using computers, teaching methods.

Grade 12

The results for Mathematics 300 Core topics are presented in Table 7. Generally they were considered by the Technical Advisory Committee to be unsatisfactory. The Core areas considered satisfactory include parts of Analytic Geometry and some algebraic items. The subtests rated unsatisfactory by the TAC were: Circular Functions, Exponents and Logarithms, and Sequences and Series. The performance on all of the Option topics was considered weak, with the least popular options exhibiting the weakest performances. These results are detailed in the other reports but they do not represent provincial results since teachers selected options which their students were to write.

Table 7

1987 Results on Core Subtests: Mathematics 300
(n = 710)

	Core Subtest	Item Numbers	No. of items	Percent Correct
C.I	Polynomial & Rational Functions	1-8	8	56
C.II	Circular Functions	9-19	11	43
C.III	Analytic Geometry	20-23	4	44
C.IV	Exponents and Logarithms	24-27	4	40
C.V	Sequences and Series	28-31	4	42

Table 8

Comparison Results for 1981 and 1986 - Grade 12
Mathematics 300 (n = 374)

Subtest	No. of Items	Average[a] % Correct 1981	1986	Change[b] in %
A. Relations and Functions	9	54	51	-3
B. Exponential and Logarithmic Functions	6	51	54	+3
C. Circular Functions	6	50	52	
D. Trigonometric Identities	3	41	35	-6
E. Trigonometry	5	53	49	-6
F. Systems of Equations	2	}	Not tested	
G. Inequalities	3	}	in 1986.	
H. Progressions	3	44	47	+3
I. Permutations, Combinations, and Binomial Theorem	5	61	40	-21

[a]Average percent correct figures are rounded to the nearest whole percent.
[b]The change in percent correct for a subtest is given only when the difference in mean scores (average number correct) from 1981 to 1986 is statistically significant ($p<.05$).

In the 1981-1986 comparison testing for **Mathematics 300** slight increases in performance appeared in Exponential and Logarithmic Functions and in Progressions. Declines of some concern were noted in three areas, namely, Trigonometry, Trigonometric Identities, and Relations and Functions. Performance in the latter area was rated mediocre in 1981. It should be noted in interpreting the data in Table 8 that Permutations and Combinations was an option topic in the 1986 curriculum, but required in 1981.

In 1987 the overall performance in **Mathematics 301** was considered by the TAC to be satisfactory. Data for the Core topics is given in Table 9. There were weaknesses in the Algebra and Trigonometry sections, but otherwise the Core topics were satisfactory. The data on Option topics were not possible to interpret due to the low numbers of students who wrote any single option. For example, no students in the provincial sample wrote the Digital Logic option and very few wrote the Annuities and Depreciation options. The options attracting the most attention are Interpretation of Graphs, Quadratic Equations, Investments, and Permutations and Combinations. See Chapter VI of the Final Report for more details.

No comparison testing was done in 1986 for **Mathematics 301** because of the implementation of the new curriculum since 1981.

Table 9

1987 Results on Core Subtests: Mathematics 301
(n = 542)

	Core Subtest	Item Numbers	Number of items	Percent Correct
C.I	Consumer Mathematics	1-10	10	68
C.II	Algebra	11-22	12	54
C.III	Trigonometry	23-26	4	51
C.IV	Statistics	27-30	4	50

On the **General Mathematics Test** written in both 1981 and 1986, Mathematics 300 students exhibited a (statistically significant) lower performance on every subtest in 1986. Similar declines were noted for Mathematics 301 students, and for those with no grade 12 mathematics.

The results for the Mathematics 300 student group who wrote this general arithmetic test are given in Table 10. Results for the Mathematics 301 group and for the group of students who had taken no grade 12 mathematics are in the Final Report.

Table 10

Topical Subtest Results for 1981 and 1986 - Grade 12

General Test: Students with Mathematics 300

	Subtest	No. of Items	Average[a] % Correct 1981	1986	Change[b] in %
A.	Number Systems and Operations				
	A1 Basic Operations	9	91	84	-7
	A2 Ratios and interrelationships among fractions, decimals and percents	6	88	83	-5
B.	Measurement	4	94	94	
C.	Geometry	7	83	77	-6
D.	Algebraic Concepts	4	81	76	-5
E.	Graphs and Statistics	5	89	70	-19
F.	Consumer Applications	15	83	74	-9

[a] [b] Average percent correct figures are rounded to the nearest whole percent. The change in percent correct for a subtest is given only when the difference in mean scores (average number correct) from 1981 to 1986 is statistically significant ($p<.05$).

Results from the teacher questionnaires indicated that most grade 12 mathematics teachers have had teaching experience at both junior and senior high levels and teach courses in both the "00" and "01" streams, although fewer than one-third have taught one of the advanced option courses (Mathematics 305). About half of them teach mathematics full time and over 75% teach mathematics 60% time or more. Lecture and demonstration are the dominant instructional modes with little use of concrete materials or computers, although calculators are widely used. Homework is assigned much more frequently in Mathematics 300 than in Mathematics 301.

The strict election of option topics as outlined in the Guide in both courses is ignored in practice by teachers. Large proportions of teachers select parts of options to teach. In some cases, teachers report that they do not teach any options. The majority of Mathematics 301 teachers felt that options should be retained, but one-half of Mathematics 300 teachers felt that the entire course should be compulsory, i.e., no options.

Even more strongly than in 1981, teachers expressed the view that less mathematics learning is taking place in the semester system than in the full-year system. They recognize that less teaching and learning time is available and that less content is covered.

Recommendations

General Comments

The assessment provides direction to mathematics education in the province. Recommendations for each grade level tested are presented in the following pages. There are, however, certain issues that reappeared at different grade levels which should be mentioned here. The most common recurring issue was that modifications should be made to the curriculum. At the grade 3, 6, and 9 levels, modifications related to problem solving, estimation, and the use of calculators and computers in the classroom. The Technical Advisory Committee proposed that Manitoba Education should study the issue of options in both the grade 9 and 12 programs. This is not to say that there has been a call for the revamping of the entire curriculum: there were instead suggestions that certain refinements should be made which would reflect changing technology and changed emphases.

Perhaps the most surprising findings in the entire assessment were the results of the grade 12 general mathematics comparison tests. Declines from 1981 were noted in virtually all subtests for all grade 12 groups (Mathematics 300 and 301 as well as for the group that has taken no grade 12 mathematics). A recommendation relating to the study of this issue has been made. Lower performance levels in applications and problem solving at the other grade levels were also a concern to the Technical Advisory Committee, especially since there has been such an emphasis on problem solving in mathematics education in recent years.

Recommendations to Grades 3 and 6

TO TEACHERS

That mathematics be taught at least the recommended number of minutes per day (i.e.,45).

That, where appropriate, the use of calculators be included in the mathematics program.

That problem solving receive increased emphasis at all levels.

That concrete materials be used in the introduction and maintenance of concepts and skill development.

That activity centres be included in the mathematics program to provide motivation as well as reinforcement.

That particular attention be paid to the transition from concrete manipulation to symbolic recording of students' work.

That more emphasis be given to the study of area, volume, and capacity, a topic important also for the science curriculum.

That continued attention be paid to the teaching of the SI metric system of measurement.

That estimation in numerical computation be taught as outlined in the Curriculum Guide.

That more attention be paid to estimation in numerical computation, rounding off, and the relationship between them.

That work with fractions, both conceptually and computationally, be given increased emphasis. [Grade 6]

That work with decimals, both conceptually and computationally, be emphasized.

TO SCHOOL DIVISIONS

That mathematics be taught at least the recommended number of minutes per day (i.e., 45).

That problem solving become an integral part of the school curriculum and of mathematics classroom activity at all levels.

That, where appropriate, the use of calculators be included in the school mathematics program and that explicit instruction be provided in the use of the calculator.

That teachers be provided with appropriate materials and professional development to teach measurement (length, area, volume, and capacity). [Grade 3]

That activity centres be included in the mathematics program to provide motivation as well as reinforcement.

That professional development be provided in the areas of need indicated by teachers: teaching problem solving, enrichment mathematics, using computers in teaching mathematics, manipulative materials, remediation in mathematics, teaching methods, using calculators (grade 6 only).

That consideration be given to professional development workshops in the metric system and in the teaching of concepts in elementary mathematics.

TO MANITOBA EDUCATION

That guidelines for appropriate calculator use be included in any future elementary mathematics curriculum guide.

That Manitoba Education support the premise that problem solving is an integral part of the curriculum and of mathematics classroom activity at all levels.

That professional development be provided in measurement concepts, problem solving and in the teaching of elementary mathematics concepts.

That professional development be provided in the areas of need indicated by teachers: teaching problem solving, enrichment mathematics, using computers in teaching mathematics, manipulative materials, remediation in mathematics, teaching methods, using calculators (grade 6 only).

TO FACULTIES OF EDUCATION

That problem solving techniques receive greater emphasis in teacher education programs.

That greater attention be focussed on the teaching of elementary school concepts.

Grade 9

TO TEACHERS

That problem solving strategies continue to be integrated into all parts of the curriculum.

That the topic of estimation be given renewed emphasis in the grade 9 program.

That repeating decimals be studied after the necessary algebraic concepts have been taught.

That work with computers and calculators become an integral part of the grade 9 school curriculum.

TO SCHOOL DIVISIONS

That problem solving strategies continue to be integrated into the school curriculum, and where appropriate, professional development be instituted.

That the topic of estimation be given renewed emphasis in the grade 9 program.

That work with computers and calculators become an integral part of the grade 9 school curriculum.

That inservice programs be organized on the appropriate use of the calculator and computer.

That inservice programs in the teaching of introductory algebra with emphasis on the use of concrete materials be organized.

That professional development be provided in the areas of need indicated by teachers: remediation, enrichment mathematics, teaching problem solving, using computers in teaching mathematics, teaching methods in mathematics.

That school division superintendents ensure that grade 9 mathematics teachers have an adequate professional and academic background for their teaching assignments.

TO MANITOBA EDUCATION

That problem solving strategies continue to be integrated into the curriculum, and where appropriate, professional development be instituted.

That consideration be given for the inclusion of the Algebra option as a core topic for all students.

That estimation be given greater emphasis in the curriculum.

That inservice programs in the teaching of introductory algebra with emphasis on the use of concrete materials be organized.

That work with computers and calculators become an integral part of the grade 9 curriculum.

That inservice programs be organized on the appropriate use of the calculator and computer.

That professional development be provided in the areas of need indicated by teachers: remediation, enrichment mathematics, teaching problem solving, using computers in teaching mathematics, teaching methods in mathematics.

That Manitoba Education encourage school divisions to assign teachers with an adequate background for their teaching assignments.

That Manitoba Education encourage the introduction of upgrading or refresher courses for junior high mathematics teachers.

That consideration be given to modifying the curriculum guide for grade 9, to include the topics noted in these recommendations.

TO FACULTIES OF EDUCATION

That faculties of education ensure that their mathematics education students be familiar with:

- **the teaching of problem solving**
- **the use of manipulative materials in the teaching of algebra**
- **the appropriate use of calculators**
- **estimation concepts.**

That faculties of education consider the introduction of upgrading or refresher courses for junior high teachers of mathematics.

Grade 12

TO TEACHERS

That every effort be made to increase students' mathematical vocabulary by constantly using correct and appropriate mathematical notation and terminology.

That the use of transformations as a foundational concept in the development of relations and functions be emphasized throughout Mathematics 300.

TO SCHOOL DIVISIONS

That school divisions determine and provide for the professional development needs of their high school mathematics teachers.

That the counselling of students in Mathematics 300 be examined to determine the reasons students are taking this course.

That school divisions ensure that sufficient time is available so that teachers are able to teach the entire mathematics curriculum.

School division superintendents should ensure that schools do not grant Mathematics 301 credits to students who have been enrolled in Mathematics 300 and for some reason will not be issued Mathematics 300 credits.

TO MANITOBA EDUCATION

That the factors that motivate students to select Mathematics 300 be examined by Manitoba Education.

That the core/option format of Mathematics 300 and the designation of particular topics as "options" be examined.

That Mathematics 301 option topics be reassessed to determine whether this part of the curriculum should be revised.

That Manitoba Education develops and maintains the Student Academic Record System in such a way that analysis over time can be made on numbers of students enrolled and numbers of students who have successfully completed individual courses.

That Manitoba Education studies the issue of low performance at the Mathematics 300 level and implement strategies to redress this problem.

That Manitoba Education reviews the issue of the low general arithmetic skill levels of Manitoba high school students and implement appropriate strategies to redress this problem.

TO FACULTIES OF EDUCATION

That faculties of education ensure that their student teachers are familiar with the variety of test item construction techniques.

That Faculty of Education students be encouraged to emphasize the importance of students' mathematical vocabulary in their teaching.

That the use of transformations as a foundational concept in the development of relations and functions be emphasized.

TO POSTSECONDARY INSTITUTIONS

That consideration be given to making Mathematics 301 the mathematics admission requirement to postsecondary programs not requiring the specific content of Mathematics 300.